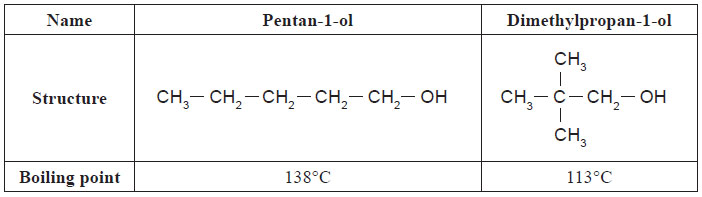
**Relate bp to bonding**

**1.** The two molecules below have the same molecular formula (C5H12O) but have different boiling points.



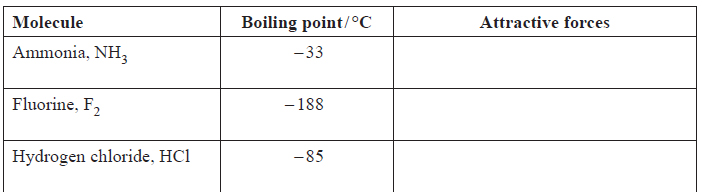
**(i)** List all the forces of attraction between these molecules in each of their liquid states.

**(ii)** Use the information above to explain the difference in the boiling points of pentan-1-ol and dimethylpropan-1-ol by comparing and contrasting the relative strengths of the attractive forces between the molecules involved.

**2.** The boiling points of ammonia, NH3, fluorine, F2, and hydrogen chloride, HCl, are given in the table

below.

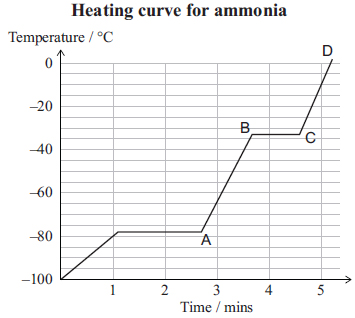
**(a)** Complete the table to identify the attractive forces between the molecules in their liquid state.



**(b)** Discuss the differences between the boiling points of NH3 and HCl, in terms of the strength of the

attractive forces between the particles involved. Then describe why F2 has the lowest boiling point.

**3.** The following graph shows the change in temperature over a five-minute period for a sample of ammonia, where a constant amount of heat was applied per minute.

****

Using the graph above, justify the physical changes occurring to ammonia between points A and D, in terms of the energy of the particles and the intermolecular forces of attraction.

**4. (a)** Explain why the temperature of liquid water does not change when it is heated at 100°C.

**b)** Use the information in the table above to compare and contrast the boiling points of hydrazine, fluoromethane, and decane in terms of the relative strengths of the attractive forces between the particles involved.



**5.** Use the information in the table to answer the following question.

|  |  |  |
| --- | --- | --- |
| **Molecule** | **Boiling point ºC** | **Molar mass / g mol–­1** |
| Water, H2O | 100 | 18.0 |
| Oxygen, O2 | ­­­–183 | 32.0 |
| Hydrogen sulfide, H2S | –62 | 34 |

Compare and contrast the boiling points of water, oxygen, and hydrogen sulfide in terms of the similarities and differences in the relative strengths of the attractive forces present between particles.

**6.** Chloroethanol (HOCH2CH2Cl) and chloropropane (CH3CH2CH2Cl) have similar molar masses, but significantly different boiling points.

Identify the substance with the higher boiling point, and justify your choice.

**7.** Discuss the trend in boiling points shown in the graph below for the Group 16 hydrides.

In your discussion:

• explain why H2O has a much higher boiling point than the other hydrides

• account for the rise in boiling points from H2S to H2Te

• compare the boiling points of H2S, H2Se and H2Te, and explain the observed trend in terms of bonding AND mass.



**8. (a)** Ethanol (CH3CH2OH) and propane (CH3CH2CH3) have similar molar masses but ethanol is a liquid

at room temperature, while propane is a gas.

Identify the types of intermolecular forces for each of these substances and explain why ethanol has a higher boiling point than propane.

**(b)** Account for the difference in the boiling points of the two substances in the table below by comparing **all the intermolecular forces**.



**9.** Justify the similarity in the Δvap*H* ° of CH3Cl and CH3NH2.



**10. (i)** Account for the difference in the boiling points for the following pairs of compounds by comparing the main forces between the molecules in each case.



**(ii)**



**11.** The boiling points of HF, F2 and HCl are given below.

|  |  |
| --- | --- |
| **Molecule** | **Boiling point (°C)** |
| Hydrogen fluoride, HF | 19.5 |
| Fluorine, F2 | –188.1 |
| Hydrogen chloride, HCl | – 85.1 |

Discuss the different boiling points of hydrogen fluoride, fluorine and hydrogen chloride in terms of the

relative strengths of the intermolecular force between the particles involved.

**12.** Use the following information to answer the question below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | ethanal | propanal | butanal | ethanoic acid |
|  | 90780q4ai | 90780q4aii | 90780q4aiii | 90780q4aiv |
| ∆vap*H* / kJ mol–1 | 26 | 30 | 34 | 52 |

Discuss the trend in Δvap*H* of the compounds in the table above in terms of the **attractive** **forces** between the particles and the **factors** affecting those forces.

**13.** Discuss the nature of the forces between molecules in each of the **three** substances given in

the table below, **and** account for the variation in the melting points.



**14.** A chemistry textbook was found to include a table showing the following information.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Substance** | **Bonds broken** | Δ**fus*H* °**  **kJ mol–1** | **Melting point**  **°C** | **Boiling point**  **°C** |
| Nitrogen, N2  Heptane, C7H16  Water, H2O  Sodium chloride, NaCl | van der Waals  van der Waals  hydrogen bonds  ionic | 0.36  90.6  6  28 | – 210  37  0  801 | – 196  – 196  100  1467 |

**(a)** Describe what is meant by the term Δfus*H*°.

**(b)** A knowledge of the nature of the substances in the table would indicate that the row of data for one of the substances is obviously incorrect.

Name this substance.

Discuss the nature of bonding in the substances named in the table above, and hence clearly explain why the row of data values can be identified as incorrect.

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